

Inventory and Monitoring of Bird Populations in Florida Canyon on the Santa Rita Experimental Range.

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Abstract

The Santa Rita Experimental Range (SRER) has hosted a bird banding station in Florida Canyon (FLAC) since 1999. The station functions as a part of the Monitoring Avian Productivity and Survivorship (MAPS) program, the Molt Migration Study (MoMS), the Monitoring Avian Winter Survivorship (MAWS) program and has served as a training/evaluation site for the North American Banding Council (NABC). The analysis of data collected from observations and captures has produced an inventory of the natural history of the birds using FLAC. Further, a baseline for monitoring the productivity and diversity of the bird community now exists. As a part of the MAPS network, population trends and estimates of vital rates can be obtained. The MoMS project provides details on migration, molt and dispersal strategy for both resident and migratory species.

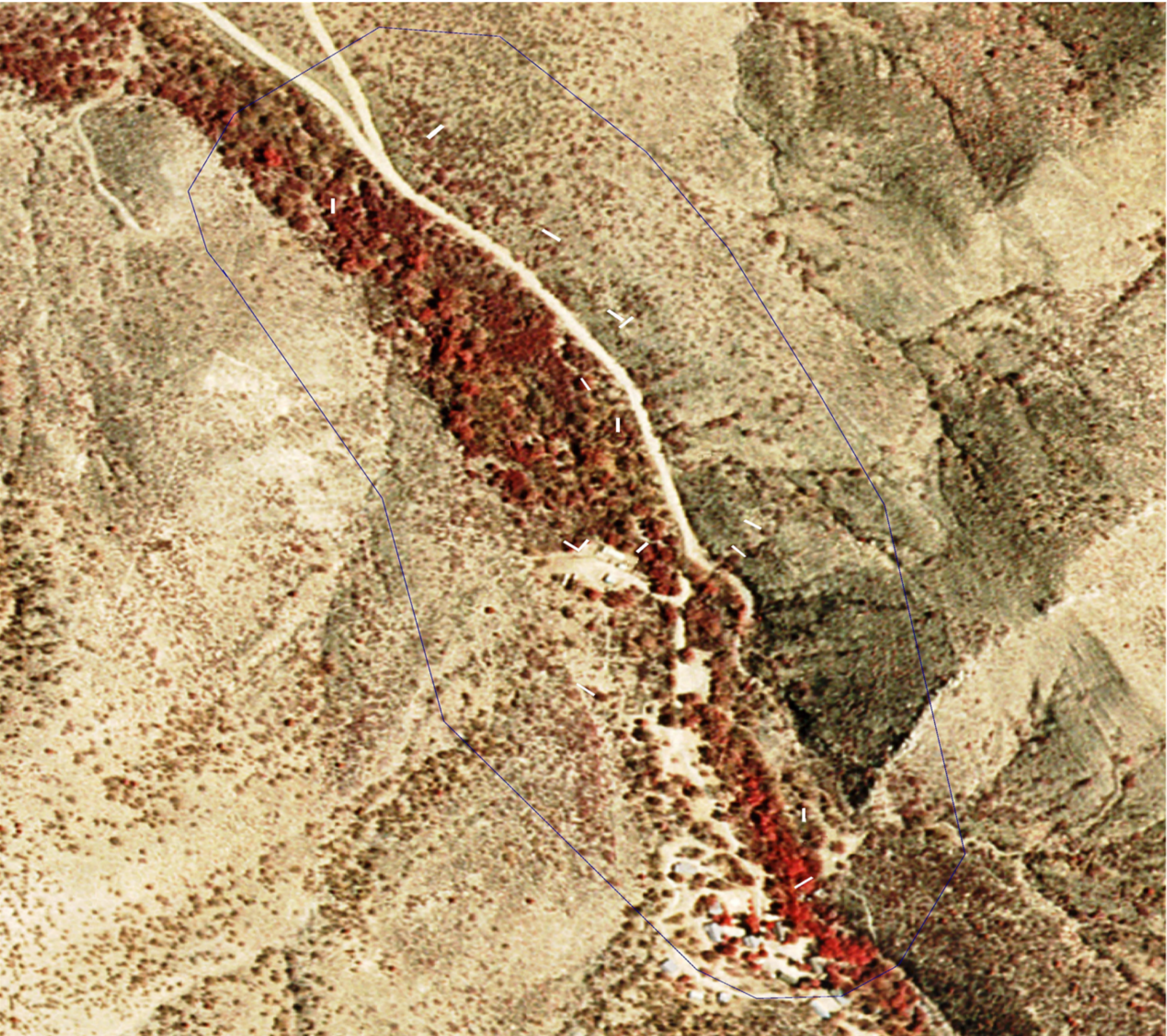
Findings

- Moderately productive site dominated by over-wintering species
- Relatively high diversity with breeders slightly dominating over-wintering and transient species
- Checklist of 142 species recorderd, 102 species banded.
- 2965 individuals banded, 390 individuals retrapped at least once
- Species Richness Curve (SRC) and Species Abundance Distribution (SAD)
- Population trend estimates for 53 of 102 species banded
- Species Accounts including several of species of concern (Lucy's Warbler, Bell's Vireo and Black-capped Gnatcatcher)

Introduction

The SRER banding station is officially known as FLAC by the MAPS program. Situated at 4200 ft in elevation, FLAC is a roughly 10 hectare section of Florida Canyon that extends for about 0.5 miles from just below the care-taker's residence at SRER downstream. Nets are equally divided between the Oak/Mesquite gallery forest along the creek and also in the Mesquite/Grassland association on the hillside flanking the creek. **Figure 1** shows the extent of the station and the placement and orientation of the net lanes.

Figure 1:
Station Boundary and Net Lane Location



The net locations are divided between two habitat types:
1) Mixed Broadleaf Series gallery forest found along the stream bed
2) Semidesert Grassland on the surrounding uplands

Birds are categorized according to their breeding and migratory status as shown in **Table 1**.

Table 1: Definition of Breeding and Migratory Status

Breeding Status		
CODE	CLASS	DEFINTION
B	Breeder	Recorded as breeding in all years
U	Usual Breeder	Recorded as breeding in > 50% of years
O	Occasional Breeder	Recorded as breeding in < 50% of years
T	Transient	Station is in breeding range but has not bred within station boundary
N	Non-breeder	Station is not within breeding range
Migratory Status		
M	Migrant	Station is within at most either the breeding or non-breeding range
A	Altitudinal Migrant	Station is within either breeding/non-breeding range depending on altitude
S	Sedentary	Species is year round station resident

Methods

- Constant effort mist netting follow MAPS protocol (DeSante et al, 2005)
- Area searches to document status follow (DeSante et al, 2005)
- Population Density Estimates computed according to Huggins et al. (2003)
- Species Richness Curves (SRC) estimated using variant of Chao et al. (2001)
- Species Abundance Distribution (SAD) estimated using Wand & Jones (1995)

Citations:

A.Chao, P.S.F. Yip, S.M. Lee, and W.T. Chu. Population size estimation based on estimating functions for closed capture-recapture models. Journal Of Statistical Planning And Inference, 213--232, January 2001.
D.F. DeSante, K.M. Burton, P.Velez, and D.Froehlich. Maps Manual: 2005 Protocol. Institute for Bird Populations. Point Reyes Station, CA, USA., 2005.
Huggins, R.; Yang, H.C.; Chao, A. & Yip, P.S.F. Population size estimation using local sample coverage for open populations. Journal Of Statistical Planning And Inference, 2003, 113, 699-714.
M.P. Wand and M.C. Jones. Kernel Smoothing. Chapman & Hall/CRC, 1995.

Productivity

The total number of individuals occurring in an area is a measure of productivity. **Figure 2** shows a summary of estimated population sizes for birds species captured at FLAC. The light red line in **Figure 2** shows the sum across all populations while the light blue lines are for individual species. Note that the productivity is dominated by 3 or perhaps 4 species. Second, these species seem to show corresponding peaks, most notably in 2001 and 2003. The initial rate of rise is only partially sampling bias. As seen in **Figure 3**, a sister station at Tumacacori National Historical Park (TUMA) shows very similar fluctuations. The correlations between widely separated sites implies large-scale environemntal effects. Future work will use Principle Components Analysis to look for correlations between the various species and with environmental variables to attempt to explain the observed variation.

Figure 2:
Population Sizes and Total for FLAC

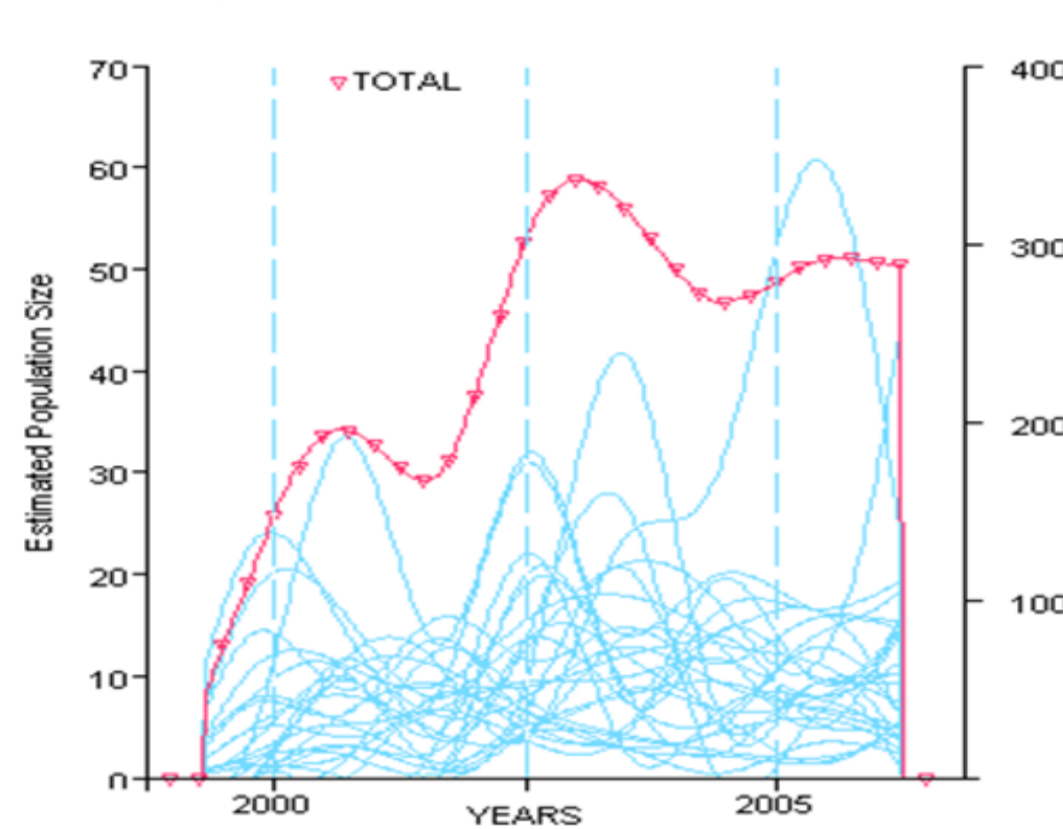


Figure 3:
Total Population Sizes for FLAC and TUMA

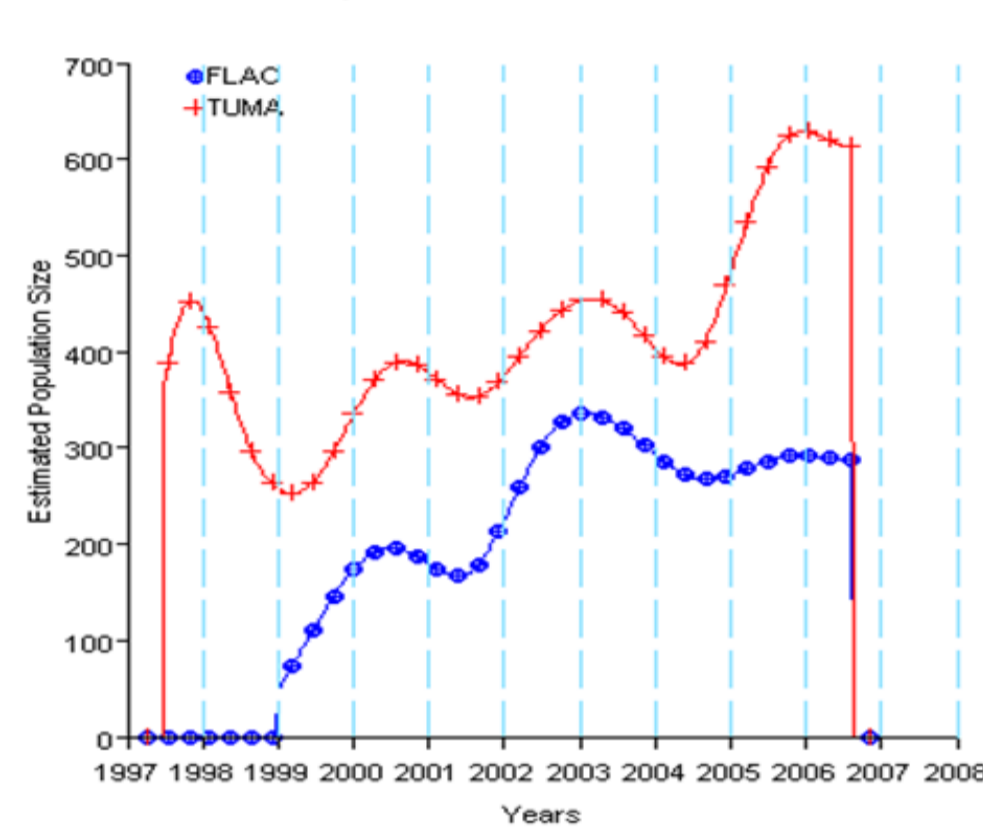


Figure 2 contains curves from 103 species. **Table 2** lists the top 21 species by average density. The species are classified by breeding and migratory status as defined in **Table 1**.

Table 2: Status of most abundant species at FLAC ranked by average density.

STATUS	CODE	COMMON NAME	Average Density
N,M	HETH	Hermit Thrush	6.3
N,M	RCKI	Ruby-crowned Kinglet	3.2
B,M	BHGR	Black-headed Grosbeak	2.8
B,M	BEVI	Bell's Vireo	1.9
B,M	VABU	Varied Bunting	1.8
N,M	CHSP	Chipping Sparrow	1.5
B,S	CANT	Canyon Towhee	1.4
B,S	NOMO	Northern Mockingbird	1.2
N,M	WCSP	White-crowned Sparrow	1.2
T,M	WETA	Western Tanager	1.2
B,S	NOCA	Northern Cardinal	1.2
B,S	BTSP	Black-throated Sparrow	1.1
B,S	BEWR	Bewick's Wren	1.1
N,M	WIWA	Wilson's Warbler	1
B,M	SUTA	Summer Tanager	0.9
B,S	VERD	Verdin	0.9
N,M	SWTH	Swainson's Thrush	0.9
B,S	RCSP	Rufous-crowned Sparrow	0.9
T,M	WEFL	Western Flycatcher	0.8
B,M	BLGR	Blue Grosbeak	0.7
B,S	LEGO	Lesser Goldfinch	0.7

The most abundant species found at FLAC are non-breeding migrants. The non-breeding migrants may be either passage migrants or winter residents, however, this list includes just two passage migrants, WIWA and WEFL. Thus, the most abundant species are over-wintering migrants, then migrant breeders, sedentary breeders and then passage migrants. The Species Abundance Distribution (SAD), presented below, provides a more graphical presentation of these results.

Species Abundance Distribution

The SAD plots density of species versus abundance and provides a measure of diversity by showing a relationship between population size and species richness. The SAD reveals the distribution of commonness and rarity within the community. The SAD plots density versus the logarithm of population size to compress the overall range and expand the details in the interior of the range where clustering tends to occur. As shown in **Table 2**, winter migrants comprise the most abundant species. The SAD shows that the most abundant species account for only a small fraction of the diversity while breeders, transients and migrants share in the dominance of diversity. The left-hand mode is probably an artifact. The rare species lack sufficient sample size for the estimators and so are biased low. Thus, there are probably only two modes. The decomposition reflects this. Breeders and non-breeders each account for roughly one quarter of the diversity. Transient species, which typically have large home ranges and low density, account for another quarter with the rest made up by the irregular breeders.

Figure 4:
SAD at FLAC According to Breeding Status

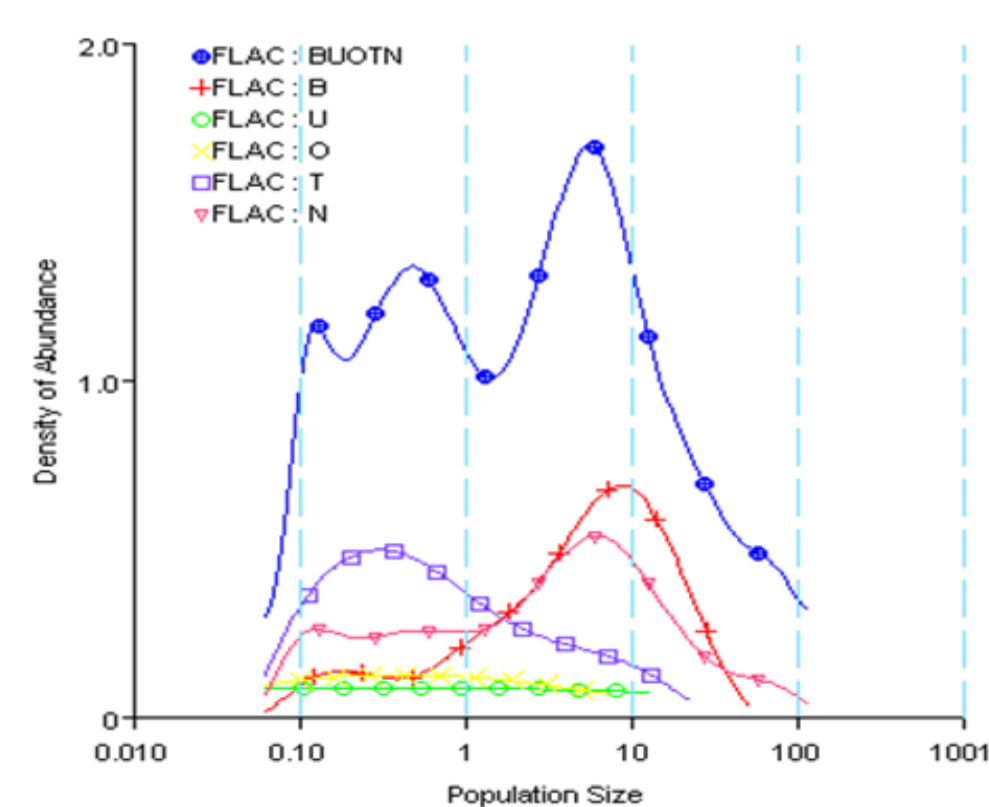


Figure 5 indicates that overall, migrants dominate the diversity at FLAC. The right-most mode comprises mostly migratory species that over-winter or breed at FLAC. From **Figure 4**, breeders and non-breeders account for nearly equal proportions of the diversity. So, sedentary and migratory breeders are roughly present in equal proportions. The second mode contains primarily transients and to a lesser extent non-breeders. These non-breeders tend to be passage migrants. Although a relatively small part of the diversity at FLAC, these species may use FLAC as a stop-over point to refuel and molt. The individual components approximate the log-normal form usually associated with SAD curves. Similar shapes result from TUMA but the roles of transients is much reduced in favor of passage migrants. Finally, note that the probability of detection for the constituent species must be heterogeneous. This point is addressed next.

Species Richness Curves

There are three principle processes that contribute to the species richness in an area:

- 1) Sampling Effort
- 2) Sampling Scale
- 3) Habitat Heterogeneity

First, consider sampling effort. The raw count of species captured under-estimates the true species richness. So, methods used for population estimation are used to correct for sampling effort. As seen in **Figure 5**, detection probabilities differ between species so Chao's (2001) Abundance-based Coverage Estimator (ACE) is used to correct for these effects. **Figure 6** shows the results of the ACE method. Note that the estimator requires about two years of data to arrive at roughly 122 species. The banding protocols exclude about 25 species that occur at FLAC but will not be included in the banding data base. Over the nine years of operation, 142 species have been recorded either by capture and banding or through area searches. Thus, the ACE method, in this case, converges quickly to a reasonable estimate of the "true" richness. **Figures 6** and **7** present the various components of the SRC as was done for the SAD. The convergence of breeders is fastest with non-breeders lagging by about one year. The reason for this is that sampling began just before the breeding season of 1999 and so data on breeders lead data on non-breeders. Non-breeders and breeders comprise the most abundant classes in the SAD so the estimation of detection probabilities for these classes converges quickest.

Sampling Scale refers to both space and time, assuming that all species that occur always get detected. Colonization and extinction have implied scales of space and time. For a single station, like FLAC, the spatial scale is more or less fixed. However, the time scale chosen strongly influences the diversity measured. For example, short term fluctuations in the overall SRC coincide with increases in transient species. Irruptive species and transient movements of montane species corresponding to snowstorms account for much of the increase. The breeding components the SRC are still increasing even after nine years of sampling. This is most likely not a sampling effect. Rather, it reflects the ongoing turnover of species at FLAC. On the time scale of this study, local colonization has not yet reached a balance point with local extinction. Further, documentation of breeding status lags behind initial discovery. **Figure 7** shows that the sedentary species, rather than the migrants, show a stronger increasing trend than the migrants. For example, Black-capped Gnatcatchers numbers have fluctuated in Arizona since their discovery in 1971. Few had been reported during the 1980's and 1990's. They were documented breeding at Patagonia State Park in 2002 and were initially documented at FLAC in 2004. Although they could have colonized FLAC and gone extinct before 2004, they are new additions to the FLAC data set and thus appear as a colonization event. In 2005, the species was documented as a breeder.

Figure 6:
SRC by Breeding Status at FLAC

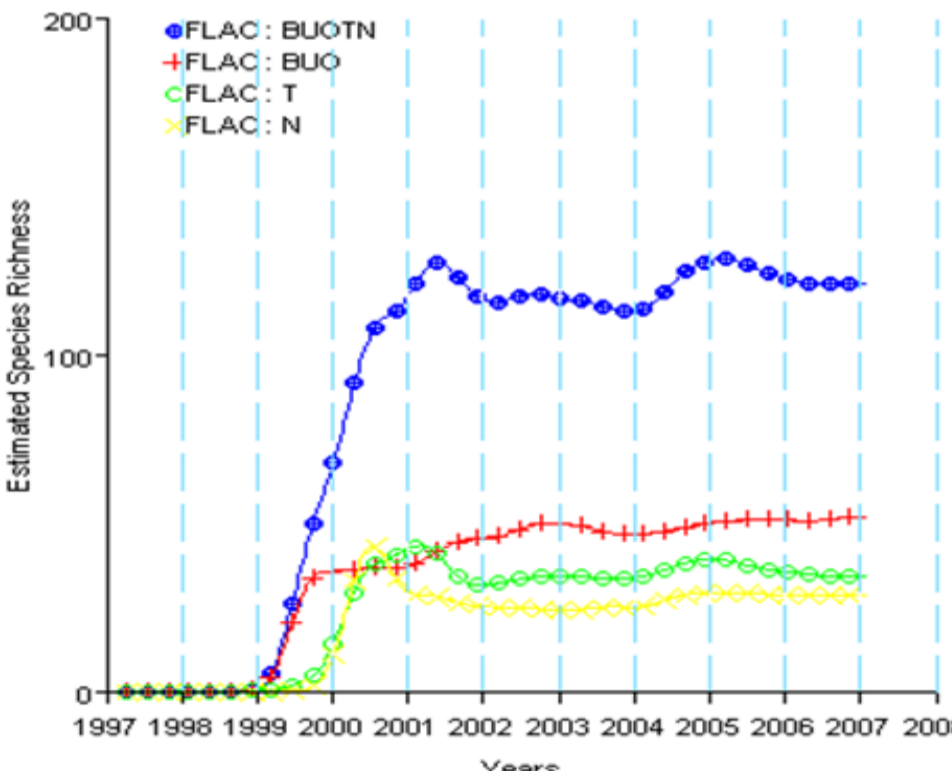
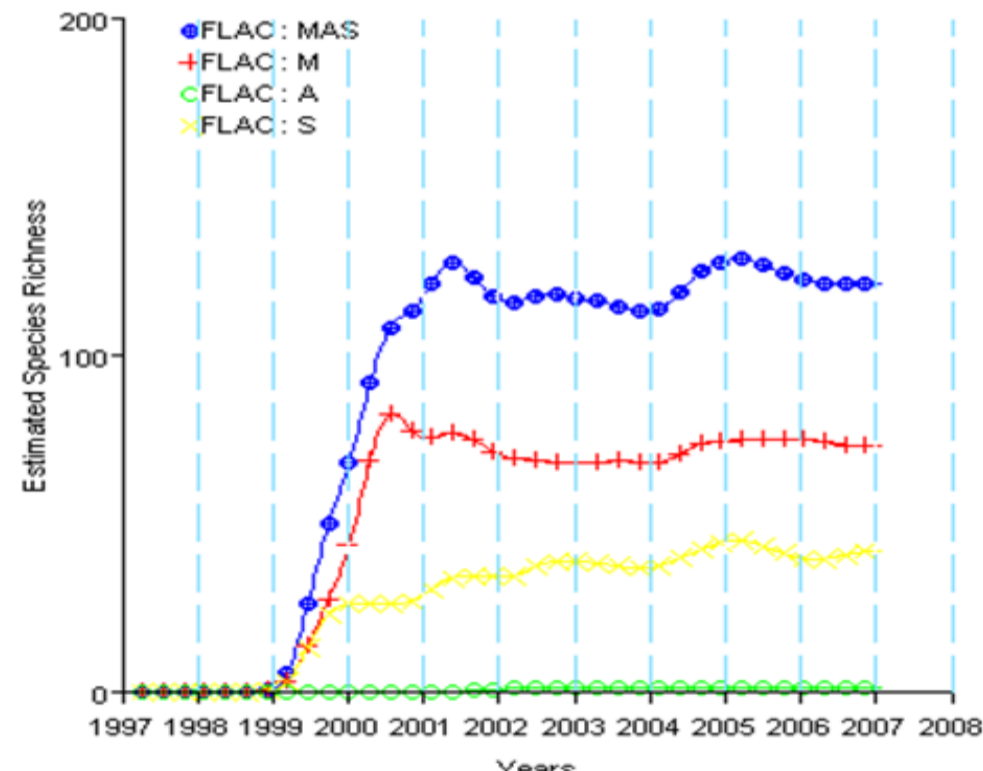


Figure 7:
SRC by Migratory Status at FLAC



Although it is intuitively obvious that habitat diversity should increase species richness, it is very difficult to quantify. A comparative approach may shed some light. **Figure 8** compares FLAC to its sister station, TUMA. As is shown in **Figure 3**, TUMA is more productive than FLAC. TUMA is located on the Santa Cruz River and has its net lanes split between both Cottonwood-dominated Riparian habitats and Semi-desert grasslands dominated by mesquite. In both stations, the breeding components have converged rapidly and stations evidently have similar local diversity because both support similar numbers of breeding and over-wintering species. However, FLAC is located on a steep elevation gradient providing relatively higher regional, or beta, habitat diversity. Many of the breeding montane species pass directly through FLAC as passage migrants while many transients from the Santa Cruz and passage migrants pass through the station. Thus, transients are also a large component of diversity at FLAC due to the short distance to both high elevations and the Santa Cruz River. Notably, relatively few altitudinal migrants (Steller's Jay, Band-tailed Pigeon) account for much of the diversity at FLAC. FLAC shows rapid convergence to relatively high diversity while TUMA shows a slower increase. However, the non-breeders are still increasing at TUMA due to rare migrants and vagrants. Given enough time, many of the species detected at FLAC may also occur at TUMA.

Figure 8:
SRC of FLAC and TUMA

